

Automated user documentation generation based on the Eclipse application model

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Abstract—An application’s user documentation, also referred to as the user manual, is one of the core elements required in application distribution. While there exist many tools to aid an application’s developer in creating and maintaining documentation on and for the code itself, there are no tools that complement code development with user documentation for modern graphical applications.

Approaches like literate programming are not applicable to this scenario, as not a library, but a full application is to be documented to an end-user. Documentation generation on applications up to now was only partially feasible due to the gap between the code and its semantics.

The new generation of Eclipse rich client platform developed applications is based on an application model, closing a broad semantic gap between code and visible interface. We use this application model to provide a semantic description for the contained elements. Combined with the internal relationships of the application model, these semantic descriptions are aggregated to well-structured user documentations that comply to the ISO/IEC 26514.

This paper delivers a report on the Écrit research project, where the potentials and limitations of user documentation generation based on the Eclipse application model were investigated.

I. INTRODUCTION

An application’s documentation is one of the first ports of call for the user. While there exist a myriad of tools and techniques for documentation generation targeted from the developer to the developer (developer documentation), documentation generation tools targeted at the applications end-user (user documentation) are barely available.

This is due to several facts and differences when it comes to generating user and developer documentation:

- 1) Developer documentation is targeted at single artifacts like classes and packages only, not considering any inter-relations¹.
- 2) The user documentation has to describe the meaning of the program that emerges out of program execution (e.g., its visual interface and interaction capabilities) while the developer documentation describes the meaning of the single implementation artifacts.
- 3) The implementation artifacts (classes, packages etc.) are not aware of their structured meaning (e.g., class

ClassX is the controller of model type TypeA or TypeB).

- 4) The implementation classes are not aware of their semantic (e.g., user interface, controller, ...) in the application.

The new generation of Eclipse-based Rich Client Platform (RCP) [2, p. 89] applications is developed on the basis of an application model [3, sect. 17], which for the first time provides information on the structure and inter-connections of the application’s components, thus partially remedying facts 3 and 4.

The application model is agnostic to the actual programming language of the implementation classes, only referencing them. Therefore, there is no limit on the implementation language used. This makes the results applicable to any other language or application framework that adopts the Eclipse application model. Additionally, analysis on the application model can be performed without the application actually running, by examining the respective model files only.

In [4] we introduced an approach to provide user documentation on the basis of the Eclipse application model, outlined the technical and scientific approach and identified four core issues to be analyzed in order to provide a meaningful proposition to the main research question: *What are the potentials and limitations of user documentation generation based on the Eclipse application model?*

Generation of application software user documentation is currently seen as a separate process with respect to the software development, potentially leading to differences between the user documentation and the actual presentation and behavior of the application. As one of the main requirements to documentation is its timeliness and synchronicity to the code, documentation and development life-cycle have to somehow be dubbed making this an additional topic considered in this paper.

This paper presents the Écrit research project, covering both the technical realization, the research approach, and the outcome on the stated question.

II. STATE OF THE ART

Up to now, research on automatic documentation generation was mainly focused on developer documentation. Concepts like literate programming [5] and projects like I-Doc [6] represent activities in this field. Approaches that try to automatically

¹The Intent project [1] provides a framework for expressing such inter-relations.

generate end-user documentation, like [7] and [8], generate the documentation by additional models or constructs that need to be maintained independently from the application.

The Eclipse environment is one of the most popular development environments for software. Generation 4 of Eclipse RCP development defines an application model², as the base for the application's user interface. This new application model allows to derive the required information, by the aforementioned approaches for documentation creation, remedying the requirement of additional, documentation specific, models.

The Eclipse application model features 37 different element types, which may be arranged into the following categories:

- *Visual Adjustment* elements determine the composition of the user interface. This category contains elements such as `Part`, `Perspective`, `Window`, `PartStack`, ...
- *Action Initiation* elements are the visual representation of an action to be executed, such as a `MenuItem` or a `ToolItem`. They are embedded as visual elements, where e.g., a `ToolItem` is represented as a clickable icon (cf. figure 3 showing the embedding of a `ToolItem` in a `Part` view menu).
- *Action Execution* elements connect the abstract definition of actions within the application model to the actual implementation classes. Part of this are, among others, `Commands` and their respective `Handlers`.
- *Dynamic Elements* provide dynamic instances of action initiation elements within the application.
- *Extension Elements* allow for the extension of the application model. This enables one to interfere with any aspect of the application model that might require adaptation.
- *Meta Elements* are used to express application model internal connections.

In the software development process, each application model element instance is created due to a certain development requirement (such as a use case or a user story). This development requirement describes a specific task to be solved, which in turn contains the documentation on how to solve it (e.g., by the formulated user story). By tagging this information, the *semantic description*, to the model element, a documented model element is created. Assuming this has consistently been done to the entire application model, the result will be a *documented application model* (cf. figure 1).

The main standard specifying the structure and characteristic of a software documentation is ISO/IEC 26514 [9]. This specification sets the objective for the generated user documentation, although the approach should easily satisfy other documentation structures and/or means of documentation.

III. THE CORE ISSUES

In order to break down the main research question, stated in sect. I, we identified four core issues [4, sect. 4]. We briefly describe these core issues in this section and the respective answer that was found in the course of the project.

²The current version of the application model can be found on <http://git.eclipse.org/c/platform/eclipse.platform.ui.git/tree/bundles/org.eclipse.e4.ui.model.workbench/model/UIElements.ecore>.

A. Mapping the application model to the documentation artifacts

Given an ISO26514 [9] conforming user documentation template, we created based on the specification, the question was *whether the application model is currently expressive enough to allow for the mapping of application model elements to documentation elements*.

ISO26514 requires [9, p. 46] the following components to be contained (in order) in the user manual

- 1) Identification data
- 2) Table of contents
- 3) Introduction
- 4) Information for use of the documentation
- 5) Concept of operations
- 6) Procedures
- 7) Information on software commands
- 8) Error messages and problem resolution
- 9) Glossary
- 10) Navigational features

Components 1,2, 4 and 10 emerge out of the documentation artifact to be created (e.g., L^AT_EX documentation generated table of contents), hence they are excluded from the core question - we refer to such components as *soft documentation elements*.

The remaining components require diverse information from the application model, so we have to find separate answers. The general pre-condition for all components, however, is that the application model has been documented (as described in sect. II) and that the application implements its tasks by representing them within the application model.

That is, functionality within the application may either be developed programmatically only, or by involving model elements. One may either use a programmatic approach, i.e., use `Action` classes directly embedded into the user interface classes to solve a task, or define a `Command` element within the application model, backed by its respective `Handler` class(es), represented in the user interface by a contribution item. Both ways will lead to the functionality being available in the application, yet only the `Command` approach leads to a model visibility of the functionality's existence, as depicted in figure 2.

3) *Introduction*: Has to contain soft documentation elements (e.g., document purpose, audience, ...) and a brief overview of the software's purpose, functions, and operating environment.

This component can not be satisfied by deriving information out of the model. On the other hand, the introduction is a general description of the application that can directly be derived from other documents of early software development phases, e.g., requirements or analysis documentations.

5) *Concept of operations*: Has to contain information on *Software installation and uninstallation, orientation to use the features of the graphical user interface and navigation through the software to access and to exit from functions*.

This component can be generated out of the application model, except for the software installation sub-component,

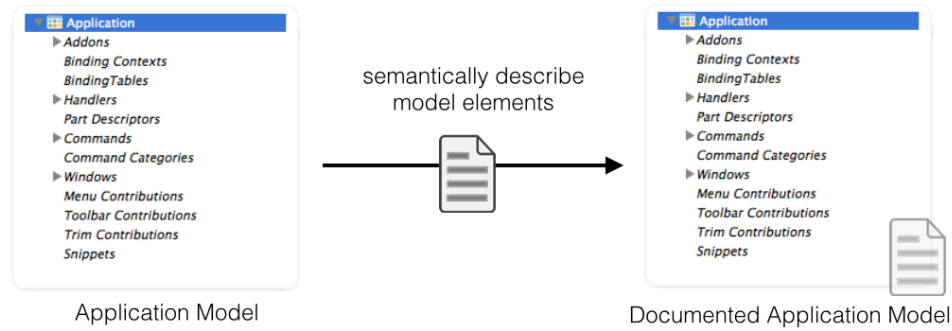


Fig. 1. Providing the semantic description of the model elements creates a documented application model.

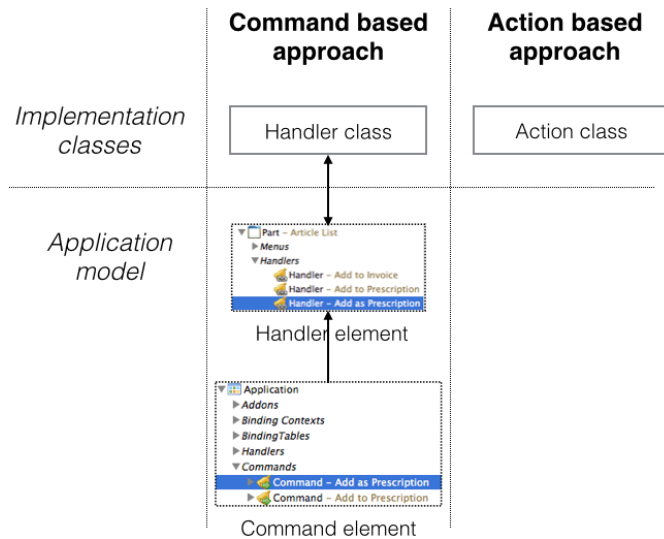


Fig. 2. To be visible within the application model, functionality has to be implemented using the Command based approach.

as this is part of the deployment and not the development procedure.

The sub-component on orientation documents basic user interface usage and hence is derivable through the nature of the development framework. If one, for example, uses the Eclipse RCP framework for development, parts of the framework documentation may be re-used in this component.

The sub-component on the navigation can be derived from the application model, as it contains all the *Perspectives*, which in turn contain *Parts* describing the single views visible to the user (cf. figure 3).

6) *Procedures*: A procedure is an ordered series of steps that specify how to perform a task. This component describes the handling of complex tasks that require multiple software commands, as described in the following section (III-A7), to be executed in order.

There exists the programmatic concept of cheat sheets [10, p. 165]. This feature, however, has not yet been ported to the application model. Hence, this sub-component is currently not satisfiable out of the application model.

7) *Information on software commands*: This component has to provide information on the commands, respective *Actions*, available. For each command it has to be documented what its parameters, pre-requirements and possible results (completion information or error message) are.

As all commands are provided within the application model, this sub-component can be satisfied. Given the semantic description of each command (cf. figure 5) a meaningful documentation can be provided. By further analysis on the application model, it is also possible to determine all initiators (that is the action initiation items as described in sect. II) of the respective command.

8) *Error messages and problem resolution*: Execution of commands may lead to error messages being presented to the user. This component is to describe all possible presented error messages and information on how to resolve the respective problem.

Error messages are not represented within the application model, hence it is currently not possible to derive this section.

9) *Glossary*: The glossary has to describe all specialist vocabulary used in the specific application. This information is not part of the application model, hence it is not possible to be generated. Typically, a glossary is created anyway during the analysis phase of the software development, and it can thus be used for the user documentation as well.

One may assume, however, that the application contains programmatic objects modelling their real-world counterparts. If these objects are created using a corresponding modelling technology, such as EMF [11], a big degree of this component could be generated by parsing the underlying information of the generated domain model.

Conclusion While major parts of the documentation may already be satisfied out of the given application model, it is not yet possible to satisfy all requirements. Providing an extension to the application with respect to these elements may however easily complete the generation of the user documentation.

The approach of a direct mapping between the application model and documentation artifacts was refused, as the specification is too fuzzy in this regard, and the requirements of such a model would be too concrete. We refer to creating a document model for further processing instead, for details see

section V-B.

B. Combining documentation artifacts and application model

The development process, in the course of creating the application itself, generates documentation artifacts (e.g., user stories) and meta-information on the application context (e.g., domain knowledge).

These artifacts and meta-information have to be part of the application user documentation. To create a generable documentation, however, we have to find a formal connection between these artifacts and meta-information and the created application model elements (forming the application itself). In [4, figure 4] we already identified such a connection, namely the connection between *Action* (as defined in [9]) and *ActingEntity*.

The respective core issue here was *to what extent is the connection of elements in the application model and application documentation extendable?*

During the course of the project we found out that the extension of the mapping is not relevant, as it emerges out of the embedding of the already identified *ActingEntity* connection within the application. That is, cf. figure 3, given a connection of (*ActingEntity*, *Action*) the specific action is embedded in the form of an initiatable item (button or menu item) at a specific place in the user interface.

So here only the grouping of actions may be of interest, but this is not relevant for the documentation.

Conclusion The element, through its placement in the application method, bears sufficient contextual information in order to determine more connection information.

C. Combining development and documentation

The application model can be modified by providing model fragments which get merged at runtime providing a *combined application model*. So the question here was *how to combine the Eclipse RCP development with the documentation development, considering the dynamic structure of a delivered product*.

In Eclipse RCP we have a set of plugins and features, that eventually get combined into a product forming the main distribution artifact (i.e., the final application). So given a set of different plugins it is possible to create different products with different features resulting in separate products for which a respective user documentation is to be created.

Both the main application model and the fragments carry their own semantic description, so the combination into one model generates a new documented application model. The approach thus does not differ from an application where we only have a single model, with the additional merging step only.

Figure 4 shows that the original approach, as presented in [4, sect. 4.3] could basically be adopted. A user documentation can either be created out of a single main application model (this is not possible for a fragment) or a product.

There exist several products containing only a single application model, neglecting the possibility to use fragments. This

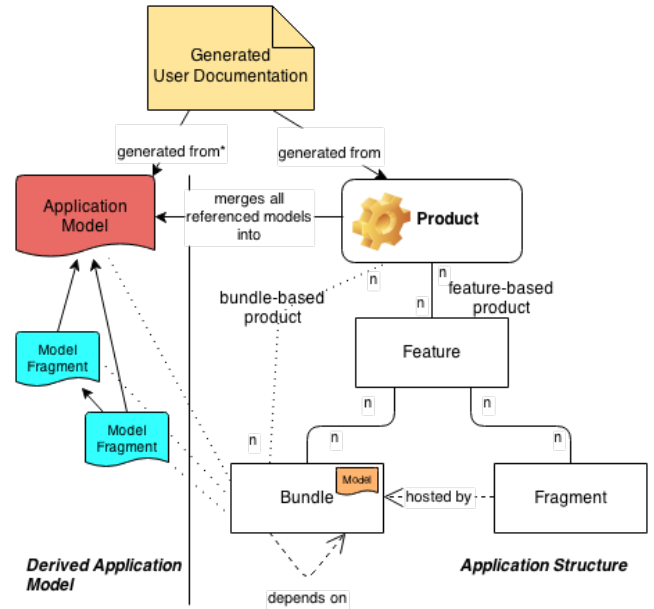


Fig. 4. User documentation can be created out of a single application model or a product representing a combined set of functionality.

may be due to an early design phase, where no extension is required, or due to the nature of the project itself. Allowing to create the documentation out of a single application model, in addition to a combined application model generated out of a product, allows for earlier integration of documentation creation in the development process.

As the semantic description is contained within the actual development artifacts, they inherit its versioning.

Conclusion We effectively combined the development with the documentation process, as the necessity to document an element emerges at the time it is created. This led us to coining the term Documentation Aware Development which will be further elaborated in section VII.

D. Determine the solution's applicability

A programming framework aims to enable the creation of almost any kind of software. So the question here is *to what types of applications a sufficient result may be achieved in terms of a usable documentation*.

This question boils down to an objective and subjective part. Objective requirements on *completeness* [9, sect. 11.1] and *accuracy* [9, sect. 11.2] are easily verifiable, and can be fulfilled using a generated documentation. The subjective perception of the documentation by the user, however, can only be statistically determined, which was not feasible in the course of the project. The overall quality of the generated user documentation, however, depends to a very high degree on the quality of the application model and its documentation.

Conclusion Applicability measurement was changed to the objectively determinable factors completeness and accuracy. To this end we conducted an analysis on existing, Eclipse

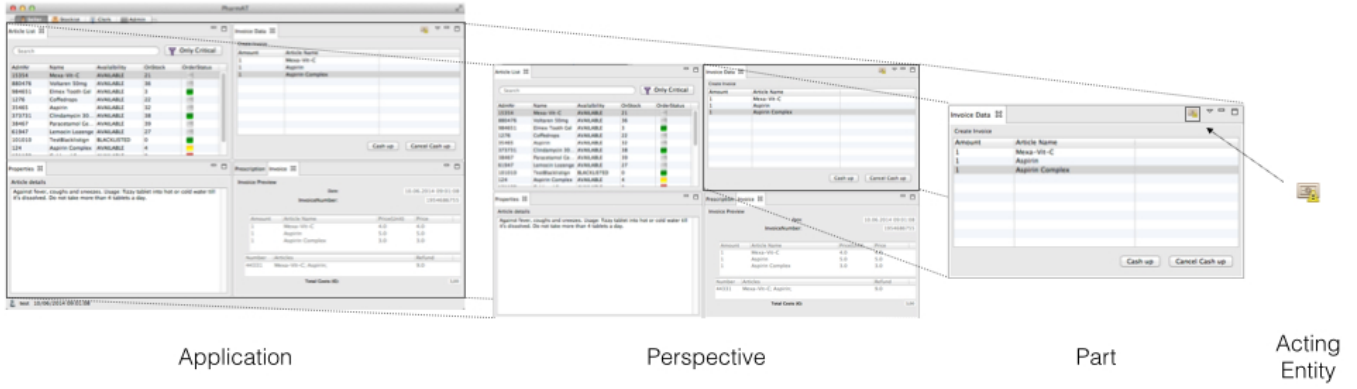


Fig. 3. Deriving user interface context information out of a single (ActingEntity,Action) connection

application model based, open source projects. For details please see section VI.

IV. STARTING POINT: SAMPLE APPLICATION

In order to treat the issues, as mentioned in sect. III, and to generate the toolkit for automated user manual generation, we needed a sample application to derive the requirements from. To this end, the Pharmacy Austria (PharmAT)³ application was specified and implemented.

The application is comprised of 14 user stories with 4 different user roles, resembling a representative subset of the tasks in an Austrian pharmacy. During the specification phase it became already clear which basic views and commands would have to be presented to the respective application users (that is user roles).

To harness this gathered information right away, a stub application model was created, containing the set of views and commands, with their semantic description, as required by the user stories. As for each user role a dedicated perspective was designated, the views could already be assigned to their respective perspective leading to a relatively advanced (with respect to the development phase) and already documented application model.

With the template of an ISO26514 conform user documentation on the output site, implementation of PharmAT was conducted. Information required by the template was fed back to the input fields for semantic description in the application model, finally leading to the current Écrit toolkit as described in the following section.

V. THE ÉCRIT TOOLKIT

The Écrit toolkit [12] consists of two separate software packages: An extension of the Eclipse application model editor to allow adding the semantic description and the actual project generating the documentation.

³The PharmAT application and the referenced artifacts are available at https://github.com/ecrit/pharmacy_at.

A. Eclipse application model editor extension

The Eclipse application model editor is a graphical editor to configure the application model. It supports all the application model elements, and allows to configure their respective properties. In order to support the semantic description for every element contained in here, a horizontal extension possibility had to be created [13], allowing to provide cross cut properties for the application model elements.

Depending on the model element to be edited, different properties have to be presented in order to satisfy the documentation model requirements. Figure 5 shows an example for the application model element Command. Here the developer provides the description of the command, the precondition for the commands execution and the postcondition after executing the command.

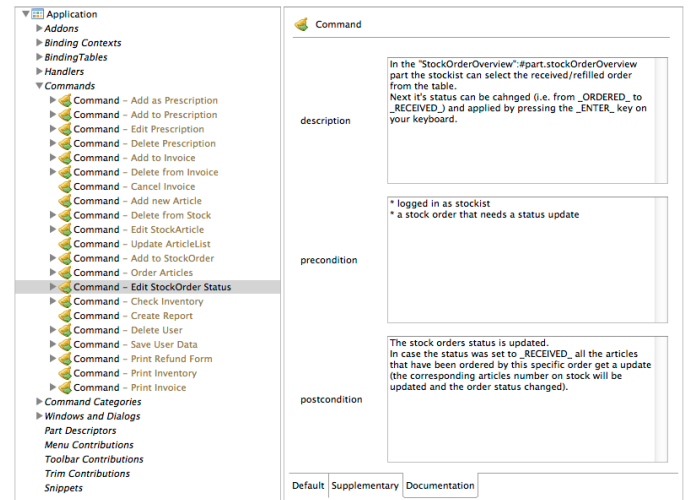


Fig. 5. Editing the semantic description of an application model command element

While description makes sense for almost any of the application, pre- and postcondition do not make sense for non-action execution elements. Considering other missing parts from the blank user documentation template also leads to values that are valid for the entire application. These are for

example an About, where the user writes about the purpose of the entire application, and some boolean values like `is multi-user` or `requires login` that allow to consider respective documentation sections.

The semantic description provided will be stored within the application model respective application fragment itself, effectively binding it with the development process.

B. Eclipse Écrit plugin

The Écrit plugin tightly integrates into the development environment. By executing it on an application model or a product element we eventually receive a (combined) application model to generate the user documentation from.

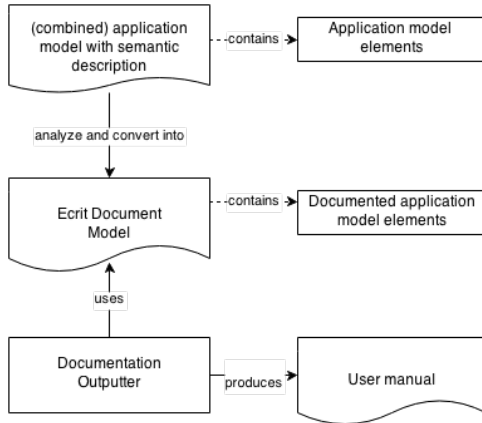


Fig. 6. The Écrit user documentation creation process

Figure 6 shows the subsequent process: The (combined) application model is analyzed and transformed into the document model. While in the application model all elements are contained as a tree, in the document model they are “enriched” with information about their embedding. That is, every element is informed about its children (applicable to visual adjustment elements), where its executable from (applicable to action execution elements, represented by action initiation elements), who is referencing it, what groups it is part of, etc.

This is necessary to provide enough contextual information for the next step, where the actual documentation artifacts are created. The outputter uses the information contained in the document model to populate an ISO26514 conform document template. Currently there exists corresponding HTML and L^AT_EX outputters.

In addition to providing the required values for the outputter, the plugin also creates depiction images for the perspectives available within the application. A depiction image shows the structure of a perspective with the arrangement of its parts in their relative position and the parts label for identification. Fig. 7 shows such a depiction image generated for a sample perspective. These images are to be embedded by the outputter in the concept of operations section (cf. sect. III-A) of the generated user documentation.

The outputter itself may work on the provided documentation model in any way. Currently we employ a simple text

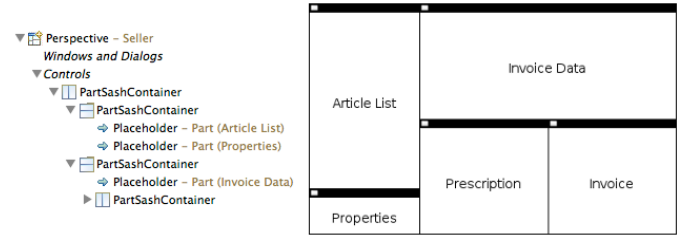


Fig. 7. Sample perspective in its model and depiction image representation.

replacement system, where the provided document template is filled with the required values.

```

1 <h2>Information on software commands</h2>
2 <#list doc.step as st>
3 <h3 id="{st.command.elementId}">{st.command.commandName}</h3>
4 <p><i>Description</i> {st.description! ""}</p>
5 <p><i>Requirements</i> {st.precondition! ""}</p>
6 <p><i>Executable by</i>
7 <ul>
8 <#list st.initiatableBy as it>
9 <#assign map = it.locationDescription>
10 <#list map?keys as key>
11 <#if map[key]?>
12 <#-- <#if map[key]?contains("Menu")>
13 <li>{key}</li> -->
14 <#if key == st.command.elementId>
15 <#-- # Skip - we don't want the command to show itself! -->
16 <#else>
17 <li><a href="{key}">{key}</a></li>
18 </#if>
19 <#else><li>{key}</li></#if>
20 </#list>
21 </#list>
  
```

Fig. 8. Sample section of the HTML outputter template.

Fig. 8 shows a section of the HTML outputter template, where the commands documented in the application model get transformed into the section information on software commands. The strings contained within the set braces pre-pended by the dollar sign reference elements of the documentation model as can be seen in figure 9.

Given this basic approach, any required output could be generated, by implementing the respective outputter. This is even encouraged by an extension point provided by the Écrit tooling on where to simply add an outputter. Details on the usage of the plugin can be found on the Écrit project page [12].

VI. EVALUATION OF THE GENERATED DOCUMENTATION

Due to the relative youth of the Eclipse 4 development platform, the amount of applications based on this system is limited. To find a representative set of Eclipse 4 applications, we started with the three major open source software hosting sites according to [14]: google-code, sourceforge and github.

As only github supports searches on the code repositories of all of its projects, we limited the further analysis to this hosting platform. A code search⁴ revealed 395 repositories containing one or more application model(s) or application fragments.

The majority of projects are of sample, educational or bug-fixing nature, with no real value with respect to our analysis and/or very limited functionality.

⁴Data collected August 8, 2014 accessible from https://github.com/ecrit/evaluation/raw/master/at.ecrit.github/rsc/result_08082014110324/toc.xls

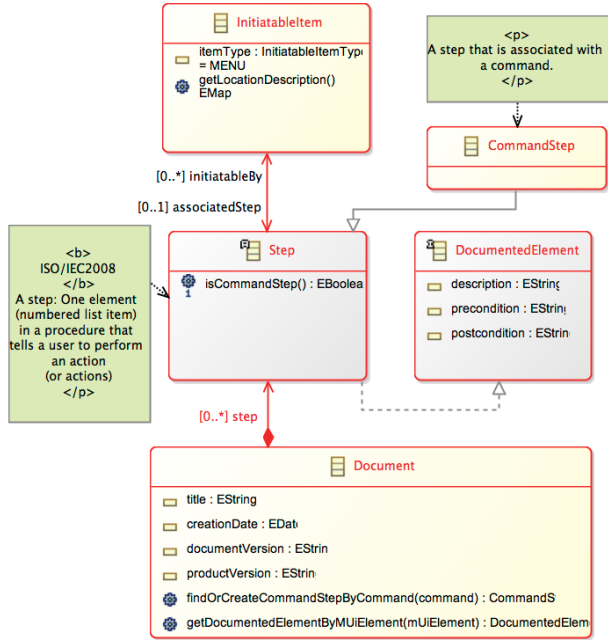


Fig. 9. Excerpt of the documentation model, showing the elements referenced out of figure 8.

To reveal applications with real-world content, we took the respective values of our sample application as orientation to set the following selection criteria:

- 1) In order for an application to be executable it has to have an application model, not a fragment only
- 2) the model contains ≥ 20 command elements
- 3) the model contains ≥ 5 part elements

As it is also possible to implement the application's functionality without employing application model elements, these boundary values also define a certain confidence that the respective project favours the modeled approach to the implementation only approach (cf. figure 2).

These criteria left us with 5 projects, to create a documentation from. The Écrit toolkit was successfully applied on all of the respective application models. As we do not have the respective semantic information on the product, however, the semantic description on the application model is missing, which makes the generated documentation useless for real users of the application.

This, however, shows the principal applicability of the Écrit plugin to suitable projects using the Eclipse 4 application model. Even though it is not a good practice for software development, Écrit could also be used to add the semantic description to the application's components ex post. We will discuss an appropriate process integrating the provision of user documentation into an agile development process in section VII.

Documentation quality is only partially an objective matter (as mentioned by the ISO26514 requirements) and most of the perception of its quality is dependent on the reader's prior knowledge. A clear assessment methodology with respect to

the output generated by the Écrit tooling is yet owed.

A possible approach to go is to query the developers of the respective projects to employ the Écrit toolkit, providing the semantic description of their application models, and then to subjectively assess on our side the time required to get familiar with their applications. This approach would, however, be only valid by employing a statistically significant number of projects and user candidates for the respective application.

To this end we may conclude that while objective factors like completeness and actuality can be measured by our approach, the real value of the generated documentation for the end-user may only be empirically derived, by further implementing the methodology and having a sufficient set of adopters.

VII. DOCUMENTATION AWARE DEVELOPMENT

In this paper we have shown that large parts of the user documentation can be automatically generated based on an appropriate documentation of the (Eclipse) application model. But this means, that the user documentation is dependent on the quality of the documentation of the application model which is tightly integrated into the development process of the corresponding software product.

ISO26515 [15] describes the process of developing user documentation in an agile environment, stating that *Designing, developing, and testing user documentation is greatly assisted by the presence of life-cycle documentation such as a documentation plan, system design document, system test plan, release records, and problem reports*. To this end we want the user documentation to be implanted directly into the core of the application, the application model.

Our approach allows to integrate the development of the user documentation into the agile software development process more tightly, this means that parts of the life-cycle documentation artifacts (e.g., user stories) can be reused for user documentation purposes, and that user documentation is up-to-date with the current application version. When [15, sect. 5.3] states that *The life cycle documentation items may not be formal or highly detailed documentation, but they are still useful in developing the user documentation*. This means for our approach that the application model documentation has to be written with the user's view in mind. The central model elements relevant for the generation of the user documentation are the user interface elements (e.g., parts, toolbars, menus, commands) and these are exactly those relating to the user behavior.

Agile development methods frequently discourage the creation of detailed engineering support documentation and detailed technical specifications. This means that technical writers often do not have source documentation from which to extrapolate feature details. [15, sect. 6.1] With our approach we provide exactly this documentation required by the technical writers, and we provide the documentation in a way that allows for automatic generation of the user documentation.

On the other hand, this means that the developers and the technical writers have to work closer together, so that

a high quality documentation can directly be inserted into the application model at the time the application model is created: *Because the communication in agile development is face to face rather than through the use of detailed life cycle documentation, information developers should be a part of the agile development teams from the beginning of the sprint, as well as during the documentation of future changes for the project backlog.* [15, sect. 6.3.1] They even suggest *pair programming with the developer and technical writer* [15, sect. 7.2] as a viable solution.

This meets a central claim of [15, sect. 6.5]: *In a project using agile development, ideally the user documentation is developed in parallel and to the same schedule as the software. This enables software to be regularly released to customers with sufficient documentation.*

It also shows the importance of the role of the technical writer during the whole software development process:

In agile development it is important that the development of the user documentation is part of the same processes as the software product life cycle, and performed in conjunction with development of the software. This enables the software and the user documentation to be tested, distributed, and maintained together. In agile development, the software cannot be considered complete without the production and validation of the associated user documentation.

Agile development processes may impact the writers of user documentation in the following ways:

- *allows for involvement early in the development process*
- *allows for influencing the software design, particularly of the user interface* [15, sect. 7.1]

Again, we see that the user interface and its documentation play a crucial role for the user documentation. Therefore, the modelling of the user interface and its documentation has to go hand in hand with the creation of the user documentation. This strong interrelation between user documentation and software design has been recognized by [15, sect. 7.2] when stating *The user documentation may itself become the design specification for the product under development, where the design details the external design features applicable to the user, such as the user interface and steps to use it, and not the internal implementation of the software. Details of the external design and information about why and how the user should use the feature are required for development of code, testing, and production of the user documentation. This approach may have other effects, such as changing the order in which user documentation is produced or tested.* We have gone one step further by automatically generating the user documentation based on the application model.

Altogether, this allows us to coin the term *Documentation Aware Development* which describes an agile software development process with a tight integration of documentation in all phases and the possibility to automatically generate sufficient and current user documentation.

VIII. CONCLUSION

In this paper we have presented an approach on how user documentation can automatically be generated from within software development projects. The implemented Écrit toolkit is a plugin for Eclipse 4. It allows to add semantic description to the components of the application model and enables the generation of accurate and consistent user documentation in different formats.

This user documentation keeps pace with the progress of the development of a software product and follows the specification of ISO/IEC 26514. It therefore perfectly complements processes for agile software development.

While the application developer has to adopt a modelled approach to develop the application, the advantage of having a substantial part of the user documentation generated out of the generated application model, might weight out the required learning. Developers starting with this new technology, might already fully adopt the modelled approach and simply have to integrate the process of providing the semantic description to the single elements into their development activities.

A next step could be to find a way to represent error messages in the application model and to extend Écrit to also handle error message artifacts. Another possible extension to Écrit is the connection with Intent project. Work on this is currently under way and will allow the generated documentation to become even more dynamic as it will be possible to link the documentation with any kind of development artifact.

We have planned to apply the current version of Écrit to concrete software development projects in small and medium enterprises (SME) and smoothly adapt Écrit to practical requirements of larger projects and to integrate users with their real demands. Especially for SMEs not capable of sustaining a specialized documentation unit, a standardization-conform pre-generated documentation template would also reduce the time required to get familiar with user documentation development requirements.

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